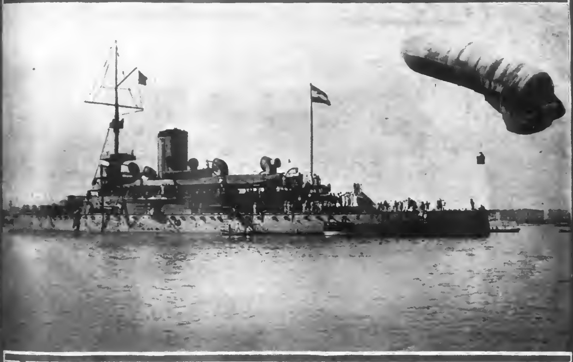
AVIATION
AND
AERONAUTICAL ENGINEERING



Central News Photo Service   Austrian Battleship "Monarch," with Kite Balloon

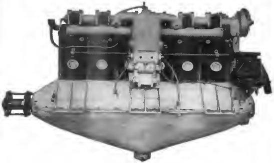
OCTOBER
1st
1917

PRICE
Fifteen
Cents

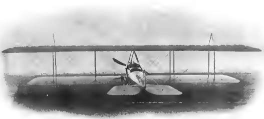
SPECIAL FEATURES

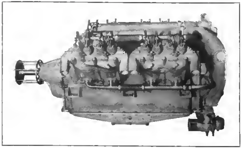
STRUT CHARTS
THE SHAPING OF AIRPLANE PROPELLERS
FOG CONDITIONS
SIMPLIFIED METHOD OF PROPELLER CALCULATION
THE PAUL SCHMITT AIRPLANE

PUBLISHED SEMI-MONTHLY
BY
THE GARDNER, MOFFAT CO., Inc.
120 W. 32nd ST. NEW YORK



Intake Side Hall-Scott, "BIG SIX" Airplane Engine





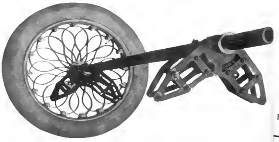
LOGICAL EQUIPMENT HE MODERN AIRPLANE

Official Government tests at the Bureau of Standards have shown that ACKERMAN WHEELS will successfully resist all the ordinary compression and side thrust shocks to which the landing gear of the modern airplane is subjected and that they have greater reserve power to meet extraordinary loads.

Constructors can greatly simplify the complex problems of landing gear design by the adoption of rigid axles with ACKERMAN WHEELS and at the same time insure a better landing support for the airplane.

The spring action of the wheel absorbs all shock before it reaches the axle, prevents rebound and makes

SHOCK ABSORBERS UNNECESSARY



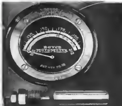
The most severe tests and actual field practice have proven the correctness of the statement that ACKERMAN WHEELS are *logical equipment* for the modern airplane.

Wheels built for any weight machine from 500 pounds up.

The ACKERMAN WHEEL COMPANY

ROCKEFELLER BUILDING - - - - CLEVELAND, OHIO


MAGNALITE
PISTONS
WALKER M. LEVETT CO.
417-419-421 EAST 23RD ST. NEW YORK
PIONEER ALUMINUM ALLOY PISTON
Send for Special Booklet
on Aluminum Piston



BOYCE MOTOMETER

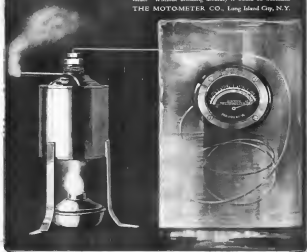
NEVER-FAILING ACCURACY

A Convincing Experiment

IF a Distance Type Boyce Moto-Meter be frozen into a cake of solid ice and the bulb inserted in a cylinder of live steam the instrument will register "Danger Steam," as accurately and unfailingly as under ordinary conditions.

Accuracy is the sole measure of the Boyce Moto-Meter's value. Without unfailing accuracy it would be worthless.

THE MOTO-METER CO., Long Island City, N.Y.



CRANKSHAFT QUALITY

Stands out as the one requirement today of the builder of

AIRCRAFT AND HIGH DUTY ENGINES

Experience only can produce a product to equal these demands.

Wyman-Gordon Company for many years, in their Research, as well as their Manufacturing Departments, have been developing along the lines that make them today able, without experiment, to supply crankshafts of

UNQUESTIONED RELIABILITY

Every stage in the production of a Wyman-Gordon crankshaft is subjected to rigid inspection and tests guaranteeing a high metallurgical quality.

Behind this perfect product is a perfect service.

Prompt attention to all orders and deliveries without delay.

WYMAN-GORDON COMPANY

WORCESTER, MASS.

OCTOBER 1, 1917

AVIATION AND AERONAUTICAL ENGINEERING

VOL. III. NO. 5

Member of the Associated Business Papers, Inc

INDEX TO CONTENTS

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*

120 WEST 32D STREET NEW YORK

WASHINGTON OFFICE, 308-10 EVENING STAR BUILDING

SUBSCRIPTION PRICE: TWO DOLLARS PER YEAR. SINGLE COPIES FIFTEEN CENTS. CANADA AND FOREIGN: TWO DOLLARS AND A HALF A YEAR. COPYRIGHT 1917, BY THE GARDNER, MOFFAT COMPANY, INC

ISSUED ON THE FIRST AND FIFTEENTH OF EACH MONTH. FORMS CLOSE FIVE DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER, AUGUST 3, 1916, AT THE POST OFFICE AT NEW YORK, N. Y., UNDER ACT OF MARCH 3, 1879.

AVIATION AND AERONAUTICAL ENGINEERING

Vol. III October 1, 1917 No. 5

Strut Charts

By H. M. Buckwald, M.E.
of the Engineering Department, Standard Aero Corp

Calculations of struts form an important part of airplane design. There are the interwing struts, the interior wing stays for drift, the body longerons and the body struts. There are also the struts of the landing gear.

Usually the lengths of these members are known, and also the load to which they will be subjected, the latter being obtained from the stress diagrams. The problem then is to find the cross-sectional area that will enable the strut to fulfill the conditions.

Struts are regarded as columns and either Rankine's or a modification of Euler's formula is used. Rankine's formula for pin-connected struts is

$$\frac{P}{A} = \frac{f}{1 + a\left(\frac{L}{k}\right)^2} \text{ where}$$

P = Crippling load of struts in pounds.
A = Area of section in sq. in.
f = Fibre stress, 5600 lbs./sq. in. for spruce (R. A. F. Data)
6250 lbs./sq. in. for ash
L = Strut length in inches.
k = Least radius of gyration of section in inches
a = A constant which depends on the value of L/k. See Fig. 1.

The results of Hunsaker's experiments on spruce struts are given in the following formulae.

For pin-connected struts

$$\frac{P}{A} = 6500 - 46.5\frac{L}{k} \text{ when } L/k \text{ is less than 70}$$

$$\frac{P}{A} = \frac{8.72E}{\left(\frac{L}{k}\right)^2} \text{ when } L/k \text{ is greater than 70}$$

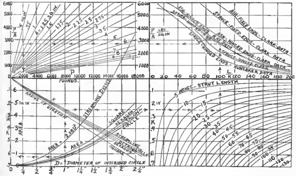


FIG. 2. UNIVERSAL STRUT CHART

For use in finding the crippling load of any size and length of spruce and ash struts. Example: Find the crippling load of a circular spruce strut one inch in diameter and 27 inches long, pin connected at the ends. Use the R.A.F. data. The dotted line shows the method of procedure. Start at the lower left hand corner at D = 1". Run vertically until the area curve for circles is reached. Looking at the area scale at the left we note that the area of a one inch circle is .785 sq. in. We proceed vertically along our D line until we reach the radius of gyration line for circles. Then project horizontally to the right until we reach our 25-inch line. Now run vertically upward to the spruce-hinged R.A.F. line. Then project horizontally to the left until the proper area line is reached. In our case it is .785 sq. in. Then drop vertically downward and we see that the crippling load of our strut is 2100 pounds.

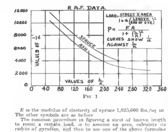


Fig 1

E is the modulus of elasticity of spruce 1,825,000 lbs./sq in The other symbols are as before

The common procedure in figuring a strut of known length to resist a certain load, is to assume an area, calculate its radius of gyration, and then to use one of the above formulae and see what crippling load our chosen section will have. This usually falls above or below our required load, and so several values of area must be tried This involves much computation, and, in order to avoid this, the following charts have been constructed

Fig 2 represents a universal strut chart which, as the name implies, may be used to find the crippling loads of struts for any section, material, length, and also for various end connections such as round, fixed, or one end round and the other fixed, and for any experimental data

The sections shown are stream line, square, hexagonal, octagonal, and circular In the upper right-hand corner of the chart there are plotted experimental results of R. A. F., Clark, and Hunsaker.*

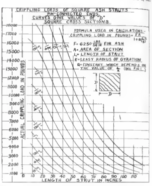


Fig 3

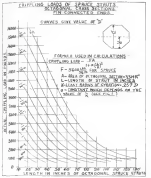


Fig 6

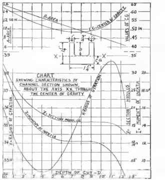


Fig. 8

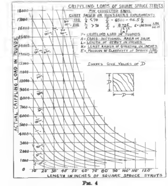


Fig. 4

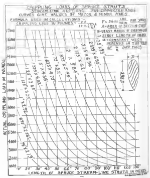


Fig. 5

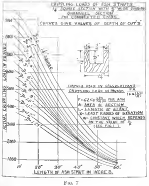


Fig. 7

From this universal chart special charts may be constructed which show at a glance the size of strut necessary for a given load and length.

These are represented in:

Fig. 3 for square ash sections: R. A. F. data.
Fig. 4 for square spruce sections: Hunsaker data.
Fig. 5 for stream-line spruce sections: R. A. F. data.
Fig. 6 for octagonal spruce sections: R. A. F. data
Fig. 7 for channel ash sections: R. A. F. data.

All of these Figs. 3 to 7 inclusive, are for pin-connected ends.

The channel section shown in Figs. 7 and 8 is very interesting. As is well known, the longerons of the body are often channeled out for lightness. The section shown is 1¼ in. sq. ash The least radius of gyration occurs about the axis XX, Fig 8 The various characteristics of this section are shown in Fig 8, and if we take these values of area and radius of gyration and use them in the universal chart, we may construct Fig 7, which shows the depth of channeling for any length and load

* R A F Data Flight, Oct 18, 1913, p 1149
Clark's Data Aerial Age, Aug 7 1916 p 635
Hunsaker's Data Aerial Age, Aug 16 1916, and AVIATION AND AERONAUTICAL ENGINEERING, June 15, 1917 p 442

Controls and Control Surfaces

In the article on "Controls and Control Surfaces," by W. J. Waterhouse, printed in the September 1 issue of AVIATION AND AERONAUTICAL ENGINEERING, the "dotted half circles" referred to under the subject of "Hinges" were omitted. They appear in the illustration printed herewith.

The Shaping of Airplane Propellers*

By Frank W. Caldwell

After the propeller has been glued up it will usually be found that the glue has set in about twelve hours. The propellar may then be removed from the clamps.

When the propeller is glued up the boards will nearly always be distorted somewhat so that strains in the wood will be introduced from this source. Additional strains are introduced from the drying out of the moisture in the glue. For this reason it is considered good practice to let the propeller stand about a week before roughing it out.

Where the propeller has been glued up in step form, the rough shaping is usually done by means of a duplicating machine or by some form of router. A good many of these have been built and some of them are shown in the accompanying sketches.

Fig. 1 shows a rather crude form of rough shaping device which seems to work very well.

Fig. 2 shows a form of cutter that is said to have been used in England for rough shaping propellers. (*Aeronautics*, Nov. 22, 1916.) The English device appears to have been built up especially for propeller work.

There is a tool already on the market, however, made by the U. S. Electrical Tool Co., Cincinnati, O., which is adaptable for this work. This tool is preferable to a cutter on a flexible shaft as the greater inertia of the tool shown prevents it from jumping or making a wavy cut. An attempt has been made to use the same apparatus for sanding but this has been unsatisfactory, as the sand roll has a tendency to jump and produce rough work.

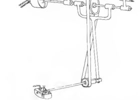


Fig. 1

Machine for Roughing Propellers With Motor and Belt Drive. This Machine, Like that Shown in Fig. 2, Is a Form of Router and Is Manipulated Entirely by Hand. Its Success Depends Somewhat on the Skill of the Operator.

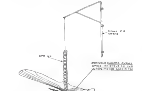


Fig. 2

Cutter and Motor for Roughing Propellers Suspended from a Light Jib Crane by Means of a Spring. The Spring Suspension Is Preferred to a Pulley and Counterweight, as It Is Found in Practice to Give Greater Freedom of Movement. In Case the Ceiling Is as High as 15 Ft. the Jib Crane May Be Omitted and the Spring Suspended Direct from the Ceiling.

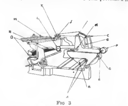


Fig. 3

Form of Propeller Shaping Machine Manufactured by Wadkin & Co. of Leicester, England. The Sketch Is Only Intended to Illustrate the Principle of Operation.

A, lead screw and nut for longitudinal feed. *B*, ways for longitudinal. *C*, lever to cam for cross feed. *D*, ways for cross feed. *E*, belt drive to cutter. *F*, source of power. *G*, equalizing link to maintain uniform distance between cutter and guide roller. *H*, pivot of guide roller support. *I*, pivot of cutter support. *J*, shroud for cutter. *K*, cutter; *L*, guide roller. *M*, propeller. *N*, form. *O*, equalizing linkage to keep axes of propeller and form parallel, which allows the blade to be kept nearly horizontal and permits free movement of the rollers.

Fig. 3 shows an automatic propeller shaping machine manufactured by Wadkin & Co. of Leicester, England. Little information is available as to what results this machine has given in practice. The cutting stroke is across the blade with a longitudinal advance at the end of each stroke. The cutting stroke of machines built in this country has been along the blade with a cross feed at the end of the stroke.

Fig. 4

Horizontal Projection of the Propeller Laid Out

Fig. 5

Block Sawed Out to Shape of the Horizontal Projection and the Vertical Projection Is Laid Out for Working Down to Angles.

Fig. 6

The Pattern for Obtaining Guide Lines for Sawing Out the Back of the Propeller.

This sketch should be considered with Figs. 5 and 7. The final piece of the propeller sawed out along the line shown in the right blade of Fig. 5. A pattern similar to that shown in Fig. 6 is then sawed out for each station and the patterns are tacked to the back of the block. This enables the saw man to obtain guide lines as shown in Fig. 7.

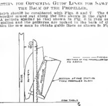


Fig. 7

Figs. 4, 5, 6 and 7 show the method of laying out and rough-forming the propeller on a bandsaw. This method is used when the propeller has been glued together in the form of a block.

Fig. 8 shows a diagrammatic sketch of a machine which has been used in this country for duplicating. The machine is provided with a guide roller, which rolls on a form of the shape of a propeller, and of a cutter having the same shape and dimensions as the guide roller. Parallel motion of the guide and the cutter is obtained by means of two horizontal ways and two vertical ways. This machine will reproduce with a fair degree of precision, but is too slow and requires too much setting up for production work.

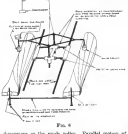


Fig. 8

Recently a few propellers have been roughed out on a machine whose operation is about the same as that of an axe-handle lathe. This machine produces very nice work, apparently, and may develop into the most practical machine yet brought out.

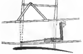
* The present article is the second of a series dealing with the construction of airplane propellers which has been contributed by the author to Aviation and Aeronautical Engineering, the first article having appeared in the issue of May 1, 1917.

The Paul Schmitt Airplane

By John Jay Ide

The Paul Schmitt airplane, one of the largest French tractor biplanes, is distinguished by a very ingenious means for varying the angle of incidence of the wings in flight. Before proceeding to describe the means employed to obtain this result, the disadvantages of the fixed angle of incidence may be briefly dwelt upon.

It is easily proved that in horizontal flight maximum efficiency can be obtained only at the speed at which the machine flies with its body horizontal. Any variation of speed, in the case of a conventional airplane, causes a change of the flying angle of the whole machine. Thus the line of flight is no longer parallel to the center line of the body. Consequently the air, instead of flowing smoothly along the body and causing skin friction only, strikes it at an angle—at higher speeds on top, at lower speeds on the bottom. In both cases loss of efficiency is the result.



Method of Altering Angle of Incidence

Let us suppose, for example, that a machine flying with its body horizontal will maintain a horizontal flight path with its engine running at three-quarter maximum speed. Now, if we increase the speed of the engine to the limit, we shall have to decrease the angle of incidence in order to maintain a horizontal flight path. Otherwise the machine will start to gain altitude. As the angle of the wings relative to the body is fixed, we are forced to change the attitude of the whole machine, i.e., fly "tail high."

Likewise for low speeds, the engine is throttled down and the angle of incidence increased by flying with the tail low. This position is always dangerous, as a tail slide may result from sudden failure of the power plant. In the case of the Paul Schmitt airplane, however, the body can be maintained horizontal at all speeds by simply changing the angle of the wings to suit conditions. The method of accomplishing this is shown in the sketch.

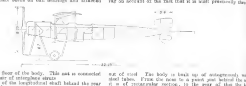
The two main planes form a unit entirely distinct from the body, which passes between the planes without touching either of them. They are connected to the body by means of a transverse tubular shaft, resting in ball bearings on a pair of inverted V stanchions and bolted at their lower ends to the upper longerons of the body. The ends of the transverse shaft are rigidly attached to two steel tubes placed fore and aft between the front and rear interplane struts. These four struts pass through the body by means of slots in the cover-

ing and are connected transversely at top and bottom by other tubes.

From the above description, it will be seen that the wings could rotate around the transverse axis until the interplane struts finally came in contact with members of the body They are prevented from doing this by means of a large nut working on a threaded shaft borne on ball bearings and attached

at a wide range of speeds The Paul Schmitt airplane can also climb very quickly; it can rise after a very short run with the tail high, a most valuable feature for seaplanes and, finally, its wings can be made to exercise a powerful braking effect.

Apart from the variable incidence, this machine is interesting on account of the fact that it is built practically throughout of steel

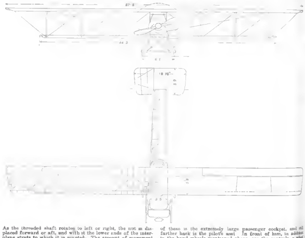


longitudinally to the floor of the body. This nut is connected by two pivots to a pair of interplane struts

On a prolongation of the longitudinal shaft behind the rear bearing are mounted two concentric sprockets from which chains pass to two handwheels in front of the pilot. Rotation of the large wheel causes the shaft to revolve slowly while the small one is geared so that a more rapid movement is obtained.

The body is built up of autogenously welded steel tubes. From the nose to a point just behind the seats, it is of rectangular section, to the rear of this the lower longerons converge, thus forming a triangular section. The elevator is very large and partly balanced.

Behind the 160 hp Le Rhône engine, mounted between double bearings in the bow, are placed the tanks To the rear



As the threaded shaft rotates to left or right, the nut is displaced forward or aft, and with it the lower ends of the interplane struts to which it is pivoted The amount of movement is such that the main planes swing through a 0 to 12 deg. arc.

By suitably varying the power, the machine can be flown

of these is the extremely large passenger cockpit, and still farther back is the pilot's seat In front of him, in addition to the hand wheels mentioned above, are the controls, a wheel operating the ailerons and elevator, and a foot bar for the rudder

Fog Conditions*

By Major G. I. Taylor

Fogs may be divided into two kinds—those which consist of small drops of water which have been precipitated from vapor in the air, and those which consist of smoke or dust particles and occur only in large towns or in manufacturing districts.

Two conditions are necessary for the formation of a smoke-fog, firstly, the wind velocity near the ground must be very small, so that the air may collect enough smoke to form a fog while passing over the town, and secondly, the air near the ground must be relatively cold compared with the air higher up for a period sufficiently long to collect enough smoke to form a fog

The relative coldness of the air near the ground has the effect of stopping the formation of vertical currents, which would tend to disperse the smoke upwards When the air near the ground is cold the fog is therefore confined to a comparatively thin layer close to the ground This condition confines the occurrence of smoke-fogs to the winter, for it is only at that time that the ground is cold for a sufficiently long period to allow enough smoke to collect to form a fog

When very light winds occur in the summer, the vertical currents in the daytime carry the smoke into the higher layers, where the wind is usually stronger, so that the smoke gets carried away Occasionally, however, the wind is very light throughout the whole of the first 6,000 or 7,000 ft In that case the smoke is carried by the vertical currents during the day up into the upper layers, but it is not carried right away In this way it forms a haze which is sometimes sufficiently opaque to obscure the sun, though it is nowhere thick enough to be called a fog

A much more frequent source of fogs is the condensation of water-vapor in the air The condensation is due either to cooling or to the mixture of two masses of air at different temperatures and containing different amounts of water-vapor

At any temperature air can only contain a certain proportion of water-vapor When it has this proportion mixed with it, it is said to be saturated. The amount of water-vapor which air can hold depends on its temperature, the higher the temperature the greater the amount of water-vapor

A frequent source of condensation is the cooling which takes place in a rising current of air owing to expansion This is the most frequent cause of clouds A fog on high land may be due to the forcing up of air from lower lying land by the contours of the ground, but a fog of this nature is practically the same thing as the lower surface of a cloud into which the high land is projecting Such a fog would make flying impossible, but even if low cloud did not come right down to the ground so as to form a fog, flying would still be practically impossible.

The chief factor which determines the temperature of the air near the earth's surface is the temperature of the surface, and nearly all fogs, both on land and at sea, are due to changes in the temperature of the earth's surface under the surface air, but there is a great difference between the land and the sea in regard to the way in which this change may take place. Out at sea the temperature of the air seldom differs by more than one or two degrees from that of the sea The temperature of the sea is only altered very slowly by heat taken from or given to the atmosphere, and there is practically no daily variation in the temperature of the sea surface The only way in which the temperature of the sea under a given mass of air may alter is by the motion of the air from a place where the sea is hot to a place where it is cold, or vice-versa.

In the case of the land, the temperature of the surface of the ground may vary rapidly through a large range Changes in the temperature of a given mass of surface air are due much more to changes in the temperature of the ground at one place than to movement of the air over ground, the temperature of which varies from place to place. The temperature of the ground depends on a great variety of different causes, such as the amount of cloud (for clouds prevent the ground from cooling at night or heating in daytime), the velocity of the wind, and the temperature of the ground for the last day or two

The most complicated and, unfortunately, the most frequent cause of fog formation is the cooling of the ground by radiation to the sky at night. This is the kind of fog with which flying men are chiefly concerned

It is a matter of common observation that fogs occur with light winds or in calms, and that they usually appear when the sky is clear of clouds This suggests that they are formed during the night on the spot at which they are observed in the morning.

To find out how far this is true and what wind velocity prevents the formation of fog, I examined all the fogs which formed in the night and were observed in the morning at Kew in the five years 1900-1905 This leaves many fogs unaccounted for, because meteorologists make their observations at about 7 a. m., and many summer fogs have cleared off by that time The wind at Kew is registered by self-recording instruments, and is tabulated every two hours. For convenience I have divided the wind velocities into four classes.

In the first class are included all the occasions when the wind velocity was between 0 and 3 3 m.p h. The second class contains winds from 3 3 to 5 5 m p.h , the third winds from 5.5

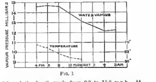


Fig. 1

to 9.2, and the fourth winds from 9 2 to 13.6 m.p.h. At 4 p m. on the afternoons of the 70 nights on which fog was reported during the period 1900-1905 there were examples of winds of each of the four classes. The actual number of cases in each of the four classes are shown in the first column of figures in Table I At 6 p m the evening calm had set in, and it will be seen on looking at the second column of figures in Table I that there were only two cases in five years in which a wind of 9.2 miles per hour or more at 6 p. m. was followed by a fog during the night At 8 p m the wind had dropped still further on the foggy nights, so that there were only two cases in the five years when a wind of more than 5 5 m.p h was followed by fog during the night. At 10 p. m there were still two cases in the third class, while there were ten cases in the second class.

Table I

Frequencies of wind of various strengths at 4 p m , 6 p m , 8 p.m., and midnight on the 70 occasions when fog was reported in the night during the years 1900-1905

Wind Velocity	4 p.m	6 p.m	8 p m.	10 p.m.	Midn
0—3 3 m p h	24	35	50	58	62
3 3—5 5	23	20	18	10	5
5 5—9 2	16	13	1	2	3
9 2—13 6	7	2	1	0	0

It will be seen that Table I can be used for forecasting, because if "no fog" had been predicted at Kew every time the wind at 8 p m. was greater than 5 5 m.p.h., only two mistakes would have been made in five years. We might also have predicted "no fog" every time the wind at 6 p m was greater than 9 2 m.p.h , and again we should have been wrong two times in five years, but since there were more occasions when the wind was greater than 5.5 m.p.h at 8 p m. than there were when it was greater than 9 2 m.p.h. at 6 p m., it is evident that we should have made more correct prophecies by using the wind at 8 p m than the wind at 6 p m. That is to say, the 8 p. m. criterion that the wind must be less than 5 5 m.p h gives rise to fewer "false alarms," when the possi-

* Abstract of a paper read before the Aeronautical Society of Great Britain

bility of fog is predicted and no fog follows, than the 6 p. m. criterion that the wind must be less than 9.2 m.p.h.

Reasoning in the same way, I found, on examining the Kew records, that the wind at 8 p. m. was a better criterion than the wind at 10 p. m. It seems, therefore, that a fog forecaster would do better by observing the wind at 8 p. m. than by observing the wind either before or after that hour.

After rejecting all nights when the wind at 8 p. m. is greater than 5.5 m.p.h., there remain a large number of nights when fog does not form. In many of these cases the sky is covered with clouds. The earth does not cool by radiation under these conditions, and consequently the surface air does not cool either, so that a fog is not to be expected. If, however, all nights when the sky is covered with clouds at 8 p. m., or any later time in the night, be rejected, there still remain many cases of calm, clear nights during which no fog forms. The question which must be looked into is, therefore, why fogs sometimes do form and sometimes do not on calm, clear nights. How is it that on two nights which appear exactly similar fog may form on one occasion and not on the other?

Fig. 2

Two possible explanations at once suggest themselves—either the ground is so warm that the temperature cannot go down enough to produce a fog when the air has the normal amount of humidity or the air is so dry that a fog would only be produced if the fall of temperature during the night were much greater than is usual on calm, clear nights. The first of these is very difficult to deal with, depending as it does on such a complicated series of causes. The second, however, seems to be the more important, which is fortunate, because it is certainly more easy for a forecaster to take account of the dryness of the air than to take account of the conditions which govern the temperature of the ground.

In order to predict whether fog is likely to appear on a calm, clear night, it is first necessary to predict the amount by which the temperature is likely to fall in the night, and then one must measure the amount of water-vapor in the air and find out whether the predicted fall in temperature is great enough to produce a fog.

At first sight the second of these seems to be a question which could be solved by purely physical reasoning. The extreme lightness of a wind during a fog suggests that the occurrence of fog at any place is due to the cooling of the ground in the neighborhood, and not to a mist which has rolled over from somewhere else. When stagnant air is cooled, one might expect the proportion of water vapor contained in the air to remain constant till the fog begins, when it would decrease, owing to the fact that some of the vapor had been precipitated as drops.

On examining the Kew records I found that on foggy nights the vapor pressure remained constant for a time and then began to decrease. In Fig 1 will be seen a curve which represents the mean vapor pressure on foggy nights in the summer. It will be seen that this curve shows the characteristic referred to. Taking this as evidence that the vapor pressure remains constant till the fog forms, I next proceeded to calculate how much the temperature would have to drop after 8 p. m. before the air became saturated. I then compared the actual amounts by which the temperatures at Kew had fallen after 8 p. m. on clear, calm nights, and found, to my surprise, that the temperature of the air near the ground falls below the dew-point at 8 p. m. nearly every night when these conditions hold. It is evident, therefore, that the vapor pressure must decrease on non-foggy nights as well as on foggy nights. I examined the clear, calm nights, when fog did not form at Kew, and found, as before, that the vapor pressure of the air near the ground remains constant during the afternoon and evening, and begins to decrease at about 10 p. m.

In Fig 2 is shown the curve which represents the mean vapor pressure on non-foggy nights in summer. The decrease in vapor pressure is evidently due to the deposition of dew on the ground. The cold up-currents which rise from the ground have deposited some of their moisture on the ground, and are therefore drier than the down-currents. When, therefore, the temperature of the air in contact with the ground falls below the dew-point, the vapor pressure of the air above it begins to fall, and the question of whether a fog arises depends on whether mixtures of the up and down-currents are capable of forming fog. If we knew the exact compositions of the up and down-currents, and also the proportions of each in any mixture, we could find out whether fog results by the use of the diagram of Fig 1.

In order to find out from the known physical properties of air mixed with water-vapor how much below the dew-point at 8 p. m. air must be cooled before fog is produced, we should have to know all about the up and down-currents which transmit the coldness from the ground to the atmosphere, and also all about the vertical distribution of the temperature and humidity.

It is obvious that forecasting cannot proceed on these lines. I have therefore tried to find out a simpler, more empirical method of forecasting. It is well known that the temperature falls more rapidly on warm summer evenings than it does in the winter when it is cold. Suppose that we make observations at 8 p. m. and that we know the average fall in temperature during a calm, clear night for any temperature at 8 p. m. Suppose also that we know how many degrees below the dew-point the air must be cooled before fog forms, then for every temperature at 8 p. m. there will be a certain amount of moisture (or a certain vapor pressure), such that if the air is moister fog is likely, whereas if the air contains less moisture fog is improbable. One could therefore draw a line on a moisture diagram * which has the following property. If the point which represents the state of the air at 8 p. m. lies below it, fog is unlikely during the night, while if the point lies above it, fog is probable.

Now, although we do not know the data by means of which

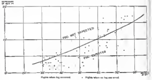


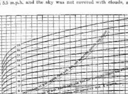
Fig. 3

we could construct the line, yet since we know theoretically that such a line should exist we can find it empirically by making all the points representing the state of the air at 8 p. m. on calm, clear nights on the diagram and drawing a line dividing the points which represents foggy nights from those which represent non-foggy nights.

As a matter of fact, this form of moisture diagram in which the state of the air is represented by a point giving the vapor pressure and the temperature is not very convenient.

Vapor pressure is not, as a rule, measured directly. The most convenient way of measuring the amount of water-vapor in the atmosphere is to measure the difference in temperature between a dry thermometer and one whose bulb is kept wet by being covered by wet muslin. When the air is dry there is considerable difference in temperature between the wet and dry bulbs, owing to the cooling of the wet bulb by evaporation. When the air is saturated the water does not evaporate from the wet bulb. The wet bulb is therefore not cooled below the temperature of the dry bulb. The difference between the temperatures of the wet and dry bulbs therefore measures how far off the air is from saturation. Tables have been drawn up showing the vapor pressure and depression of the dew-point † for various temperatures of the wet and dry bulb thermometers.

Using these tables, I took every case in which the wind and cloud conditions at 8 p. m. at Kew were suitable for the formation of fog, i.e., every case in which the wind was less than 5.5 m.p.h. and the sky was not covered with clouds, and found the depression of the dew-point. I then marked each of these on a diagram representing the state of the air by points, giving the temperature as abscissa and the depression of the dew-point as ordinate. For every night when fog occurred I marked the point as a round dot, and for every night when no fog was reported I marked a cross. The diagram is shown in Fig 3. I then drew the line shown in the figure which divides roughly the dots from the crosses. It will be seen that there are only three dots above the line, while there are 31 crosses. If, therefore, this line had been used for forecasting, on occasions when the wind and cloud conditions were suitable for fog, that no fog would occur if the point representing the state of the air at 8 p. m. were above the line in the diagram, three mistakes would have been made for 31 correct predictions. On the other hand, when the point lies below the line, the chances are about equal that a fog will occur at Kew and that it will not.



It appears, therefore, that a diagram of this form should be of some use in predicting the occurrence of fog if it applies to other places besides Kew. I find on examining the records of Oxford, Nottingham and Potsdam, that the line is in each case very close to the Kew line.

As the diagram stands, it is not very convenient to use, because, after reading the wet and dry bulb thermometers, one has to look up in a table to find the depression of the dew-point. It can be made more convenient by transferring the line to a diagram in which the state of the air is represented by a point showing the difference between wet and dry bulb readings as ordinate and the temperature as abscissa.

A diagram constructed on this principle is shown in Fig 4. The line shown in Fig 4 was transferred from Fig 3 by finding, from the tables, the difference between the wet and dry bulb readings corresponding with points in Fig. 3. The diagram may be used conveniently for predicting whether fog is likely to appear on an aerodrome or not during the night. The wet and dry bulb readings are taken at 8 p. m. If the wind is less than 5.5 m.p.h. and if the sky is not completely covered with clouds, then a fog is probable if the point on the diagram which represents the state of the air at 8 p. m. lies below the line. If the point lies above the line, fog is improbable.

If the point lies close below the line, i.e., if there is still a considerable difference between the wet and dry bulb readings, but not enough to ensure the absence of fog, fog is probable, but since the air is still unsaturated fog will not appear for some time after the readings were taken. A difference of more than a degree between the wet and dry bulb readings may be taken to indicate that fog will not appear immediately. A line has been drawn on the diagram which indicates roughly the difference which is necessary in order that fog may not appear for about four hours. This line evidently lies below the other line, and points which lie between the two indicate the probability that fog will form after midnight. It seems possible that the diagram may be of some use to flight-commanders in telling night pilots how long to stay up.

It may sometimes be convenient to make a forecast at 6 p. m. instead of at 8 p. m., though for reasons already given the 8 p. m. forecast is more likely to be correct. To allow for this contingency a third line has been drawn on the diagram above the 8 p. m. line. When the point representing the state of the air at 6 p. m. lies above this line, fog is improbable during the night.

The chance that a prediction made with this diagram will be right can be judged by looking at the diagram of Fig 3, but there is another cause which limits its usefulness in the winter, the freezing of water which is supplied to keep the wet bulb from becoming dry. When this water freezes the readings of the wet bulb become unreliable. In the summer, however, the use of the diagram should lead to a considerable improvement in forecasting the occurrence of a radiation fog.

* A diagram which shows the vapor-pressure and temperature of the air

† The depression of the dew point is the number of degrees through which the air must be cooled before dew is deposited

Book Review

"Air Navigation for Flight Officers" by A. E. Dixie, R.N. (D. Appleton & Co., New York. $4.00 223 pp.)

This book contains condensed information on the subject of aerial navigation. The subject matter is presented in a clear manner, and can be easily followed.

The author commences by giving a summary of the laws of magnetism, and applies these laws to the magnetic compass. The compass is then taken up, its construction and its mode of operation described. The errors of the compass and methods of allowing for these are then considered, and finally the method of obtaining bearings and correcting bearings is taken up.

The first five chapters are devoted to a discussion of the laws of magnetism, the compass, and the use of this instrument. The next three chapters deal with weather observations. In these chapters the author explains cloud and fog formations, weather charts, storm signals, and weather forecasting. Under the head of weather forecasting are given simple and useful rules for the forecasting of weather without the use of any instruments.

The ninth chapter deals with astronomy, and the methods employed in finding the time of sunrise, sunset, moonrise, moonset, etc. The more important constellations are pointed out by means of sketches, and the practical use of these constellations in making observations is dealt with.

In the tenth chapter Mr. Dixie goes into the theory of the construction of charts, and the method of using charts for obtaining a course, and finally gives some rules for obtaining the distance covered by an airplane when being drifted by the wind.

In the last three chapters Mr. Dixie explains the use of protractors, and gives examples in determining the course to be steered in order to intercept a hostile ship, the method employed in fixing positions, and the use of maps with conventional markings.

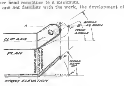
The Design of Airplane Fittings

By Randolph F. Hall

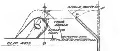
of the Thomas-Morse Aircraft Corp

The design of proper fittings for aeronautical use is one of the most important constructional details of the entire airplane. Nothing destroys the appearance of a finished machine more than a fitting out of angle. Fittings must not only be strong, but light and simple, and exposed clips of such design as to reduce head resistance to a minimum.

To any one not familiar with the work, the development of



Case I



Case II

fittings in the flat pattern is often an intricate problem and has been the cause of undue expense and poor design. The graphical methods illustrated in appended sketches of solving true angles for flat pattern may be of value to the drawing-room, inasmuch as the method is easy to comprehend, sufficiently accurate and required but little time.

CASE I.—Bending Axis Perpendicular to Clip Axis

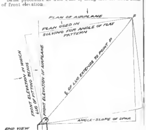
Let P be any point on lug centerline.

Projecting lug to flat plane P describes arc to P'.

In plan P will always lie in plane A B, which is perpendicular to bending axis, and to correspond to front elevation P moves to P', thus forming true angle, as shown.

CASE II.—Bending Axis Parallel to Clip Axis

Same procedure as with Case I, using side elevation instead of front elevation.



Case III

CASE III.—To Find Flat Pattern Angle of Fitting of Case I or II if Set on Sloping Spar

Same procedure as for Case I or II, correcting plan and front elevation as indicated in diagram.

The Kyle Smith Sporting Airplane

The Kyle Smith Aircraft Company is producing a light sporting model for cross-country flying and for exhibition work. Views of the machine are shown in the photographs. The main data for the machine are as follows:

Span, top, 32 ft., spleet, bottom, 22 ft., length overall, 20 ft. 9 in.; chord, 4 ft. 6 in., gap, 4 ft. 6 in., main supporting surface, 245 sq. ft., stabilizer, 18 sq. ft., elevators, 18 sq. ft., rudder, 8 sq. ft.; fin, 3 sq. ft., wing section, R. A. F. 6, main planes are staggered 20 per cent., dihedral angle 2½ deg. control, Deperdussin, wing flaps, 16 sq. ft. each, speed range 35 to 65 miles per hour, total weight, empty, 600 lb.

The airplane is of standard design, with a rather big overhang on the upper plane; by screwing two turnbuckles the overhang can be let down, and the machine will then go through a space of 22 feet. To eliminate warping, tail surfaces are made of steel tubing.

Front View

Rear View

Simplified Method of Propeller Calculation

In a paper called "The Screw Propeller in the Air," read by M. A. S. Riach on March 21 before the Aeronautical Society of Great Britain, the author developed an analytical theory of the air screw, which was based on empirical results obtained from aerofoil data such as were first enunciated by S. Drzewiecki, and later amplified by F. W. Lanchester in his work, "Aerial Flight."

The investigation of Mr. Riach and the new theory based

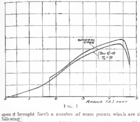


Fig. 1

upon it brought forth a number of main points which are the following:

(1) The importance of high aspect ratio, that is multiple blades.

(2) Good sections having high lift-drag values as aerofoils.

(3) Correct values for maximum efficiency.

(4) Wide blades to be employed in conjunction with the correct chord angles for best efficiency.

(5) Some uncertainty as to the correct amount of end tip loss to be allowed for.

(6) Multiple bladed air screws should, if the new theory is correct, require more brake horsepower than their two-bladed equivalents under similar conditions, but they should develop a greater thrust at the same forward and rotational speed, and their efficiency should be higher.

(7) Multiple blades raised the question of the requisite strength and consequent area of the sections from boss to tip, which cannot be decreased indefinitely without fear of bursting taking place. Advantage may, however, be taken from the fact that a very slight forward rake is usually sufficient to convert the whole stress into pure tension and consequently a much smaller section can then be employed. It should, however, be noted that the center of area of the blade sections along the blade should not in general lie on a straight line, but on a curve, the determination of which may be accomplished as a rule without much difficulty. All the sections will then be stressed in pure tension.

In order to reduce this theory for purposes of design work in the drawing office, Mr. Riach recently published in *Aeronautics* the following simplified method of propeller calculation.

The formula previously obtained for the blade constant (C_1) is given by

$$C_1 = \frac{550\ H}{8.\pi^3.n^3\ N.\rho\ \int_{r_0}^{r} Cy_1\, f(x)\, x^3 \sec A_1\ (\tan A_1 + \tan\gamma_1)\, dx}$$

Now, if V_1, the inflow velocity, is made constant for all radii, x, the above integral reduces to a simple form.

The substitution

$$f(x) = \frac{4\pi.x.\sin A_1.(\tan A_1 - \tan A)}{N.C_1\, Cy_1.(1 - \tan A_1.\tan\gamma_1)}$$

being made and inserted for $f(x)$ in the integral given above.

The integral then becomes:

$$I = \frac{2.V_1.(V+V_1)}{N.C_1\, 2.\pi n^2}\cdot\int_{r_0}^{r}\frac{x^2\{V + V_1 + 2\pi n.x\ \tan\gamma_1\}\,dx}{2\pi n.x - \tan\gamma_1\ (V+V_1)}$$

Upon examination we see that as $\tan\gamma_1$ is decreased the value of I also decreases.

Again, as r_0 decreases from some positive value toward zero, the value of I increases. [*Note.*—r_0 is usually a small positive fraction of r.]

Hence, if both $\tan\gamma_1$ and r_0 are made equal to zero, the value of I may not change appreciably as these two effects tend to neutralize each other. This is shown clearly in Fig. 1, representing the two integrals plotted graphically.

We shall then first find the value of I in the general case, when $\tan\gamma_1$ and r_0 have any values whatever, and then find the value of I when both of these quantities have a zero value.

By equating the two expressions we shall obtain the values of $\frac{r_0}{r} = K$, say, which must be satisfied if the complete integral is to have the same value when both r_0 and $\tan\gamma_1$ are zero.

This procedure leads to the following formula for K:

$$\frac{r^3}{3}\ (1-K^3)\tan\gamma_1 - \frac{K^2r^2\ (V+V_1)}{4\pi n} + \frac{r\,(1-K)\,(V+V_1)^2}{4\pi^2 n^2} +$$

$$+\frac{(V+V_1)^3}{8.\pi^3 n^3}\tan^3\gamma\ \log\frac{r - \dfrac{(V+V_1)}{2.\pi n}\tan\gamma_1}{Kr - \dfrac{(V+V_1)}{2\pi.n}\tan\gamma_1} = 0$$

A graph of K against $(V+V_1)$ is given in Fig. 2 for several diameters, and $\tan\gamma_1 = \frac{1}{20}$, $n = 20$.

It is seen that an average value of K is thus about .6, which is certainly rather high, and for an 8-ft. diameter airscrew r_0 would then be 2.4 ft.

Decreasing $\tan\gamma_1$ will decrease K.

The value of the integral when both $\tan\gamma_1$ and r_0 are zero is:

$$I_0 = \frac{V_1\,(V+V_1)^2\ d^3}{16\ \pi^2 n^2\ N\,C_1}$$

whence

$$C_1 = \frac{550\ H\ 16\ \pi^2 n^2\ N\,C_1}{8\ \pi^3 n^3\,N\,\rho\,V_1\,(V+V_1)^2\,d^3}$$

which gives

$$V_1.(V+V_1)^2 = \frac{1100\ H}{\pi\,\rho\,d^2}$$

from which the value of (V_1) may be found very simply for

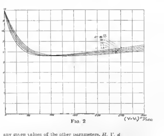


Fig. 2

any given values of the other parameters, H, V, d.

Now the same result may be obtained from R. E. Froude's theory direct, i. e., without the aerofoil theory at all.

The change in kinetic energy per sec. is:

$$\tfrac{1}{2}\ M\ [(V+2.V_1)^2 - V^2] = \tfrac{1}{2}.M\ [2\ V + 2.V_1].2.V_1 = M.[V+V_1].2.V_1$$

and M = Mass/sec. through the airscrew $= \frac{\pi}{4}d^2.(V+V_1).\rho$

and . Change in K E./sec. $= 2 \cdot \Gamma_1 \cdot (V + V_1)^2 \cdot \frac{\pi}{4} \cdot d^2 \cdot \rho$

Hence, B.H.P. necessary is given by:

$$H = \frac{2 \cdot \Gamma_1 \cdot (V + \Gamma_1)^2 \cdot \pi d^2 \cdot \rho}{4 \cdot 550} = \frac{V_1 \cdot (V + V_1)^2 \cdot \pi d^2 \cdot \rho}{1100}$$

which gives

$$V_1 \cdot (V + V_1)^2 = \frac{1100 \cdot H}{\pi d^2 \cdot \rho}$$

the same result as before.

Having thus found V_1, which is to be constant for all radii x, we proceed to find the value of C_y and hence of $C_y \cdot f(x)$ — i.e., the blade width at any radius x.

Returning to the formula, already employed in the substitution for $f(x)$, we see that:

$$C_y \cdot f(x) \cdot (\eta_1 = \frac{4 \pi x \cdot \sin A_1 \cdot (\tan A_1 - \tan \gamma_1)}{N \cdot (1 - \tan 1 \cdot \tan \gamma_1)}$$

Now $\tan \gamma_1$ was taken to be zero, so that

$$C_y \cdot f(x) \cdot C y_1 = \frac{4 \pi x \cdot \sin A_1 \cdot (\tan A_1 - \tan 1)}{N}$$

which may now be plotted graphically against (x), since $A_1 = \tan^{-1}\left(\frac{1 + V_1}{2 \pi n x}\right)$ and 1, has been previously found.

We thus obtain a graph of the form given in figure (3), which shows the value of the product $C_y \cdot f(x) \cdot Cy_1$ for any radius x.

[NOTE.—Γ_1 is actually made to have a constant value across the "disc," and hence this is not to be regarded as an approximation.]

It is then open to the designer either to vary $f(x)$ or $C y_1$ so that the product of the two shall be *proportional* to the ordinates on the curve at any radius chosen.

Having thus by a tentative process found suitable values for $f(x)$ and $C y_1$ along the blade, we can, knowing the sections to be employed at the various radii, find from the wind channel results the corresponding values of a_1, the angles of attack of these sections, corresponding to the $C y_1$ values chosen for these radii.

It only remains then to fix the angles to the plane of rotation ϕ along the blade. This can be done at once from the relation:

$$\phi = a_1 + \tan^{-1}\left(\frac{V + V_1}{2 \pi n x}\right)$$

In estimating the probable *efficiency* of the airscrew, it will be necessary to employ the *complete* formula occurring in the numerator in the general efficiency expression, since

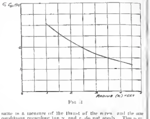


FIG. 3

same is a measure of the thrust of the screw and the same conditions regarding $\tan \gamma_1$ and r_o do not apply. This is evident from a consideration of the thrust integral:

$$\int_{r_o}^{r} C y_1 \cdot x^2 \cdot f(x) \cdot \sec^2 A_1 \cdot (1 - \tan A_1 \cdot \tan \gamma_1) \, dx$$

when it is evident that decreases of $\tan \gamma_1$ and r_o do not neutralize each other, the value of the integral becomes *larger* as r_o is decreased, $\tan \gamma_1$ does not enter into the formula when the value of $f(x)$ is substituted in the integral.

A New American Coast Patrol Airship

Within the past week the Navy Department has accepted for harbor and coast patrol service a 100 hp. airship of the non-rigid type. The vessel, illustrated herewith, took four months to build. The trials, which the manufacturer states were entirely satisfactory, comprised among others an endurance run of eight hours, which took place over a large town "somewhere in America." The airship is here shown preparatory to making a trial ascent.

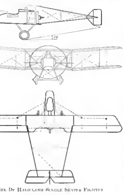
A NEW 100 HORSEPOWER NAVAL BLIMP

Digest of the Foreign Aeronautical Press

Flight (London), September 6, 1917

The De Havilland Single Seater Fighter.—According to the German aeronautical magazine *Flugsport* the De Havilland fighter, which the Royal Flying Corps extensively used during 1916, has the following characteristics:

The machine is a pusher biplane of equal span and carries the steering gear on outriggers of the Maurice Farman type. The planes consist of three sections; the center section has a span of $11\frac{1}{2}$ ft. and to this the lateral sections are attached at a dihedral angle. There are two pairs of interplane struts on each side, the tail booms are attached to the internal after struts. The ailerons are held flush with the trailing edge by rubber cords on the upper surface. The armament consists of a machine gun mounted on a pivot in front of the pilot.



THE DE HAVILLAND SINGLE SEATER FIGHTER

CHARACTERISTICS

Span, upper and lower	31 ft. 5 in.
Chord, upper and lower	4 ft. 11 in.
Overall length	22 ft. 8 in.
Height	9 ft. 4 in.
Area, upper plane with ailerons	135.2 sq. ft.
Area, lower plane with ailerons	103.3 sq. ft.
Area, total supporting	278.5 sq. ft.
Area, each aileron	15.8 sq. ft.
Area, elevators	12.8 sq. ft.
Area, rudder	7.2 sq. ft.
Stagger	None
Retreat	None
Incidence, upper and lower plane	4 deg. 30'
Incidence, stabilizer	0.8 deg.
Power plant	100 hp. monosoupape Gnome
Propeller (diameter)	7 ft. 8 in.
Speed, horizontal	93 m.p.h.
Gross weight	1047.2 lb.
Useful load	541.2 lb.
Total weight, loaded	1588.4 lb.
Lift loading	7.3 lb./sq. ft.
Power loading	15.9 lb./hp.

Tungsten from South Africa.—The great increase in the cost of the high-speed steel employed in the making of machine tools reminds one that there are large deposits of tungsten in Southern Rhodesia, at Essexvale. Although mining operations have not as yet been undertaken there on a large scale, there has been some desultory work on the alluvial or rubble wolfremite and this appears to have given rise to the idea that the deposits were only alluvial. There are, however, sixteen distinct reefs known and eleven of them have had a little work, a few feet below the surface, done on them from time to time.

In the two years after 1906, when the deposits were first prospected, a fair amount of ore was produced, but production ceased in 1909 and was not resumed for three years. Altogether about eighty-five tons of concentrate, valued at $35,825, has been marketed. The returns for 1916 are $2\frac{1}{2}$ tons, valued at $2,335, which was produced by one worker with a few natives in a 5 ft. rotary diamond washer, and by one man on another claim, who hand picked rubble and recovered 1600 lb. of wolfremite.

Allied and German Airplane Losses.—Enemy claims of Allied airplane losses and admissions of their own losses during the three first years of the war are disclosed in the accompanying tables, taken from German publications. It is needless to add that the Allies' version of the comparative losses suffered in warfare would tell quite a different story for, whereas the Allies count as "destroyed" only such craft as are reported by several observers to have crashed, the enemy lists as his victory every Allied machine that is driven down "apparently out of control," such as a nose dive or a tail spin. It is well to remark that the latter maneuvers are often employed by aviators in order to escape overwhelming odds and can, therefore, by no means be taken as indicating the loss of a machine.

The detailed enemy claims for Allied and German airplane losses for the three first years of the war are as follows:

	German	Allies
First year (1914-15)	47	72
Second year (1915-16)	373	455
Third year (1916-17)	462	1,771
Total	882	2,298

Air Fighting in August.—The British and French communiqués, published during August, show that 179 enemy airplanes and nine enemy balloons were brought down, and 118 enemy airplanes and two enemy balloons driven down. The Germans during August claim to have shot down 131 Allied airplanes and 15 Allied balloons. Eighty-six British machines are reported by our headquarters as missing. The French give no particulars as to losses and the Germans announce the loss of only five airplanes. In August, Guynemer had his fiftieth air victory and was elected an officer of the Legion of Honor. The Germans claim that in this month their "Chasing Echelon No. 4," under Capt. Richthofen, brought down its two-hundredth adversary. Eight raids by R. N. A. S. on points in Belgium are recorded.

BRITISH REPORTS

Enemy machines brought down	106
Enemy machines brought down out of control	83
British machines missing	86
Enemy balloons brought down	2
Enemy balloons driven down badly damaged	2

FRENCH REPORTS

Enemy machines brought down	73
Enemy machines driven down in their own lines	35
Enemy balloons brought down	5

GERMAN REPORTS

British, French or Belgian machines shot down	131
German loss of machines admitted	5
Allied balloons brought down	15

Aeronautics (London), August 29, 1917

The Curtiss OX-5 Aero-Engine.—This new engine resembles in the main the well-known OX-2 model. The following modifications have, however, been incorporated.

The upper half crankcase has been stiffened by extra ribs, and is being made of heavier metal. Improvements have been effected in the main bearing. The magneto bracket has been stiffened. New design breather pipes have been fitted, which result in even more economic oil consumption. The Berling D-81 magneto, of more substantial design than the A-81, is now being used. The water pump support is of more rigid construction.

Oil slingers are now fitted at each end of the crankshaft, and also a new oil strainer, which allows the screen and the

oil reservoir to be examined without dismantling the lower half of the crankcase. An improved oil level indicator has also been fitted, and a new auxiliary air valve which permits of much better functioning of the engine at low speeds and is lighter in weight. Detail improvements in the valve action have also been incorporated.

Aeronautics (**London**), **September 5, 1917**

R. H. Barnwell Dead.—R. H. Barnwell, one of the greatest pioneers of British aviation, was killed on Aug. 27 in an aviation accident near Dartford. Barnwell was flying a fast scout that had been previously flown the same day. After several loops, he spun the machine and came out, but on repeating the evolution he spun straight into the ground and was immediately killed. The witnesses came to the conclusion that Barnwell must have fainted, as he did not make any attempt to recover himself.

Barnwell was thirty-eight years old at the time of his death. He was a brother of F. S. Barnwell, designer to the British and Colonial Aeroplane Co. of Bristol, and author of "Aeroplane Design."

After having built, in 1908, an experimental monoplane, and in the following year a large biplane, Barnwell took his pilot certificate at Brooklands and eventually joined Vickers Limited, remaining with that firm up to the time of his death, first as manager of their Brooklands airdrome and later as testing pilot.

Flight (**London**), **August 30, 1917**

Parachutes for Airmen. (Editorial.)—We have before us certain correspondence on the subject of the training of airmen in the use of the parachute as a means of life saving.

We had almost decided to refrain from commenting upon it but for the statement that during the last raid on the coast an enemy airman made use of a parachute to escape from his machine when it was brought down in aerial combat. We know the uses of the parachute in free and captive balloons, but its adaptability for use in airplanes is more uncertain, principally for the reason that it is next door to impossible to carry out the necessary experiments to ascertain precisely what its measure of use may be.

The suggestion in the correspondence, to which we have referred, is that training classes should be established to teach the use of the parachute. In the abstract, the idea is excellent and we agree that the question is well worthy of very careful examination.

As we are well aware, the toll of life in the Air Services under conditions of active service is exceedingly heavy and there can be no manner of doubt that, provided some such device as the parachute can be adapted to use from a fast flying or falling aeroplane, the actual loss might be substantially reduced. There is, however, a decided question whether it is really possible to demonstrate its use under such circumstances as a part of the curriculum of training. We are very much inclined to think that the risks would be far greater than could possibly be justified. The way the matter appeals to us is that to leave an airplane by parachute is absolutely the very last resource of the airman who finds himself in extreme difficulty . . . . it supplies him with the off-chance of saving his life.

Now, to be really effective the training in its use would have more or less to reproduce those circumstances of extreme difficulty, and it is perfectly obvious that no sane commander or administration would consent to the necessary risks being taken. The fact that a German airman appears to have made use of such a device, and apparently with success, establishes a case for enquiry and, within limits, of experiment, but we should scarcely like to go so far as to say that instruction in the use of the parachute should as yet form a part of the ordinary course of training of aviators.

Novelties in Fuels, and Their Uses.—A novel method for starting and running internal combustion engines, which is the patent of F. E. Smith and Vickers, Limited, has lately been applied to automobiles, though at the moment the aircraft engine is outside the range of its application.

The fuel is a composition of various ingredients, one mixture being forty-one parts potassium nitrate, forty-one parts charcoal and eighteen parts sulphur, with sufficient moisture to make it plastic. Not the least important feature of the scheme is that by which only partial combustion is secured in the first cylinder, the residue of energy being utilised in the second cylinder by the addition of air or oxygen, the process being repeated continuously. For starting purposes, by igniting a cartridge of the fuel a reservoir can be immediately charged with gas at high pressure, which can be used for the engine.

Flying (**London**), **August 29, 1917**

The Handicap of the Wind. By F. W. Lanchester.—A scientific explanation of the work of the wind in its relation to aerial operations on the Western front. As the prevailing winds blow from the Western quarter during the greater part of the year, it becomes self-evident that the wind works for the enemy machine in case of engine trouble because it lengthens the path of its volplane and thus enables it in reach in most cases its own lines, whereas an Allied airplane suffering a breakdown will find its gliding path so shortened that the aviator will mostly have to land in No Man's Land, if he does not come down within the enemy lines. The work of the wind should, therefore, be taken into account when comparisons are made between Allied and enemy airplane losses.

The Immelmann Turn.—A favorite maneuver of enemy fighter airplanes is the so called Immelmann Turn. This is in the main made use of when the German wants to out-maneuver

THE IMMELMANN TURN
Courtesy of Flying (London)

an Allied aviator who has obtained a favorable position for attack behind and beneath the enemy's tail.

The Immelmann Turn consists essentially of three distinct phases: first, the *turnover*, in which the machine is pulled over onto its back by use of full right or left aileron and opposite ruddering; second, the *nose dive*, and third, the *recovery*, which leaves the machine flying in exactly the opposite direction to its initial flight path. In doing the Immelmann Turn the pursuer invariably overshoots his mark and finds himself, at the completion of the maneuver, at a considerably higher altitude than his opponent. The accompanying illustration depicts the second phase of the Immelmann Turn.

The Aeroplane (**London**), **August 22, 1917**

The Production of Aeroplanes and their Components. By Stepney Blakeney. (Tenth Instalment.)

Aero-Motors in Kind and Construction. By Geoffrey de Holden-Stone.

News of the Fortnight

Aircraft Board Bill Is Sent to President

The bill authorizing the creation of an Aircraft Board was passed by the Senate on Sept. 12, as reported with amendments by Senator Sheppard, Chairman of the Committee on Military Affairs, and on Sept. 27, the Senate agreed to the House amendments officially creating an Aircraft Board, without sending the measure to conference. The bill has been sent to the White House to receive the President's signature.

This bill was originally introduced into the Senate by Senator Sheppard and into the House by Congressman Murray Hulbert, under the title of the Air Board Bill. Amendments were made in the Senate that involved minor modifications and changed the title to Aircraft Board. The bill . . .

A BILL

To Create the Aircraft Board and Provide for Its Maintenance

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that for the purpose of expanding and coordinating the industrial activities relating to aircraft or parts of aircraft produced for any purpose in the United States and to facilitate generally the development of air service, a board is hereby created to be known as the Aircraft Board, herein after referred to as the board.

The board shall be composed of the Chief Signal Officer of the Army, the Chief Constructor of Navy, and not more than seven other members of recognized capacity and achievement along industrial lines to be appointed by the President, by and with the advice and consent of the Senate.

The board shall elect one of its civilian members as president thereof, and said board and tenure of office of the members thereof shall continue during the pleasure of the President, but not longer than six months after the present war. The civilian members of the board shall receive a compensation of $7,500 each per annum.

The board is hereby empowered to supervise and direct, in accordance with the requirements prescribed or approved by the Departments of War and Navy, respectively, the purchase, production, and manufacture of aircraft, engines, and all ordnance and instruments used in connection therewith, and accessories and materials therefor, including the purchase, lease, acquisition, or construction of plants for the manufacture of aircraft, engines, and accessories.

The board is also empowered to employ, either in the District of Columbia, or elsewhere, such clerks and other employees as may be necessary to the conduct of its business, including such technical experts and advisers as may be found necessary, and to fix their salaries. Such salaries shall conform to those usually paid by the Government for similar services: *Provided*, That by unanimous approval of the board higher compensation may be paid to technical experts and advisers. The board may rent suitable offices in the District of Columbia or elsewhere, purchase necessary office equipment and supplies, including scientific publications and printing, and may incur necessary administrative and contingent expenses, and for all of the expenses enumerated in this paragraph there shall be allotted by the Chief Signal Officer of the Army for the fiscal year nineteen hundred and seventeen and nineteen hundred and eighteen the sum of $100,000, or so much thereof as shall be necessary, from any appropriation now existing for or hereinafter made to the Signal Corps of the Army, and such appropriation is hereby made available for these purposes: *Provided*, That, except upon the joint and concurrent approval of the Secretary of War and the Secretary of the Navy, there shall not be established or maintained under the board any office or organization duplicating or replacing, in whole or in part, any office or organization now existing that can be properly established or maintained by appropriations made for, or available for, the military or naval services.

Large Italian Airplanes Fly to Washington

Three Italian airplanes flew from Langley Field to Washington, D. C., on Saturday, Sept. 21.

The 120-mile trip was made without mishap by the Pomilio and the Caproni machines, which made good time, but the other battleplane, an S. I. A., equipped with a Fiat engine, although the first to arrive over Washington, either ran out of gasoline or experienced some engine trouble and was forced to land in a marsh just south of Washington on the Virginia side of the Potomac, where it stuck. Lieutenant Ballerini and his observer, Lieutenant Abbetti, were uninjured.

About 11.15 the first Italian battle-plane, the 300 hp. Pomilio which was piloted by Lieutenant Baldioli of the Italian Army, was sighted. Although the third machine to leave Newport News, this was the first to arrive in Washington.

The giant Caproni biplane, powered by three 175 hp. engines, driving two tractor screws and a pusher propeller, carrying ten passengers, put in its appearance about 11.35 at a very great height. After circling about for a few minutes the pilot, Lieutenant Resnati, began to spiral down slowly.

Lieutenant Resnati made a beautiful landing, and presently his passengers and mechanics began climbing out. Among the former were Dr. William F. Durand, chairman of the National Advisory Committee for Aeronautics, Dr. Samuel W. Stratton of the Bureau of Standards, and also a member of the Advisory Committee, W. B. Stout, official photographer Ericsson, H. J. Kubel of the Geological Survey, and Captain Teppi of the Italian Army.

New American Altitude Records

Caleb Bragg, an aviator cadet in the United States Army Air Service, ascended on Sept. 19 at Hazelhurst Field to an altitude of 22,000 ft., thus establishing a new American altitude record for airplanes. Bragg used a Wright-Martin model V biplane fitted with a 150 hp. Hispano-Suiza engine built by the Simplex Works of New Brunswick, N. J.

WRIGHT-MARTIN MODEL V BIPLANE
Passed by Committee on Public Information

The flight for the altitude record of seaplanes, with pilot and two passengers, was made August 25 in a Wright-Martin flying boat, with a Hispano-Suiza engine. A height of 12,900 feet was reached.

The previous American seaplane record for pilot and two passengers was 9,524 feet, and the present American seaplane record for aviator and one passenger is 12,333 feet. This record has been allowed by the Aero Club of America.

Y. M. C. A. School for Air Mechanics

Mechanics who wish to do their "war bit" while working at their own trade are eligible, if in fit condition, to learn airplane mechanics and qualify as non-commissioned officers in the aeronautical service. They will not be expected to fly, but to take care of the airplane engines and the planes under direction of officers.

A school to train airplane mechanicians will be opened in a few days by West Side Y. M. C. A., 318 West Fifty-seventh street, New York, and the army will doubtless enlist all the graduates who can pass the required tests.

The school will be under the direction of F. S. Gostenhofer and will be assisted by a corps of instructors. The course will include thorough instruction in the mechanics of the airplane and its engine. The aero school will be under the general supervision of H. Clifford Brokaw, head of the West Side Y. M. C. A. Automobile School, which has turned out more than 15,000 automobile drivers and mechanics.

Captain Guynemer Lost

Capt. George Guynemer, the famous French aviator, is believed to be dead.

He met his death, it is supposed, in a reconnaissance flight over Flanders on which he left Dunkirk Sept. 11. Nothing has been heard of him since and it has been assumed that he was lost. French Army Headquarters issued on Sept. 25 a confirmatory report.

CAPTAIN GEORGES GUYNEMER
Photo American Press Assn.

Captain Guynemer, who attained world wide fame by his exploits, was perhaps the most brilliant aviator of the war. He was last cited in the official French announcement of September 10 for having won his fiftieth aerial victory. An unofficial press dispatch a few days earlier said he had accounted for fifty-two enemy machines. He was 21 years old.

Only a little more than two years ago Capt. Guynemer was a simple soldier. He entered the French Army as a volunteer after having been rejected five times by the medical inspectors. Joining the Aviation Corps he rose rapidly in rank until he attained the grade of Captain, winning the Cross of the Legion of Honor, the Military Medal, the War Cross, and almost every other honor which his country could bestow.

The young aviator took part in many spectacular fights, and had the narrowest escapes on several occasions. In March of last year he was wounded.

One of the most spectacular achievements of Capt. Guynemer was the shooting down of three German airplanes in two minutes and thirty seconds in September, 1916. On one occasion he was forced to descend between the French and German trenches, but was able to escape.

Guynemer operated his airplane alone, serving as both pilot and gunner.

Non-Stop Flight from Turin to Rome

Captain Marchese Giulio Laureati of the Italian Royal Flying Corps who established on Aug. 29 last a new world's aviation distance record in circuit by flying from Turin to Naples and back without a stop, a distance of 920 miles, made on Sept. 25 another remarkable nonstop flight, which took him in a straight line from Turin to Rome.

Captain Laureati left Turin at 8.28, Italian time, and landed at Hounslow at 2.50 in the afternoon, having completed a journey of 656 miles in 7 hr., 22 min., 30 sec.

Captain Laureati flew an Aila machine and carried a mechanic as passenger and two machine guns.

From Turin he followed the railway as far as Susa, on the Italian frontier. Crossing the Alps by Mont Cenis at an altitude of nearly 12,000 ft., he passed over Lanslebourg and rejoined the railway at Modane. During the crossing of the Alps he encountered rough weather, and throughout the whole journey had to face a strong northwesterly wind.

From Modane, still following the line of railway, the aviator traveled northwest to Culoz, which he reached in an hour and forty minutes from Turin, and, continuing on the same line, passed over Verdun-sur-le-Doubs. He crossed the Cote d'Or Department and proceeded by way of Flavigny and Bussy across the Department of Seine et Marne, passing to the east of Paris and completing his transit of France by way of Compiegne, Amiens, and Cap Gris Nez.

Throughout this part of the journey he kept an average height of about 9,900 ft. He crossed the Channel in 15 min., dropped to 2,000 ft. to pick up his bearings, and completed his journey to Hounslow without misadventure except for a slight detour made in error over Hendon.

He carried with him in addition to copies of an Italian newspaper an autograph letter from his King to King George and letters to Lloyd George, Lord Derby, Mr. Balfour, Lord Montagu of Beaulieu, and the Lord Mayor of London.

War Industries Board Reorganized

The Council of National Defense has announced the reorganization under the War Industries Board of the Automotive Products Committee, which will have advisory supervision of all matters involving the use of internal combustion engines, including the production of motor cars, trucks and ambulances, tractors, motor-boats and airplane engines. The Committee will serve under the administration of Robert S. Brookings, member of the War Industries Board in charge of finished products.

The membership of the committee, as reorganized, is as follows: Chairman, H. L. Horning, tractors and trucks; C. W. Stiger, representing the Motor and Accessory Association; Colonel Chauncey M. Baker of the Quartermaster's Corps; Coker F. Clarkson, representing the Society of Automotive Engineers; Frank W. Russell, representing the Manufacturers Aircraft Association; T. W. Henderson, representing the Motor-cycle Association; Henry R. Sutphen, representing the Motor-boat Association and Hugh Frayne, member of the War Industries Board, representing labor.

A special auxiliary committee has been appointed to work on the military truck program in co-operation with the Quartermaster's Corps. Sub-committees will also be appointed on priority, gasoline and military motor-cycles.

Transatlantic Flight Projected

Preparations are being made in England for crossing the Atlantic from east to west by airplane in one day, according to an announcement made by J. A. Whitehead, governing director of the Whitehead Aircraft, Limited, to the London *Daily Sketch*.

"When our plans are full matured," he said, "we shall make a trip which will be the most sensational in the whole history of aviation. The aeroplane will be piloted by Herbert Sykes, who anticipates leaving Hanworth Park, Feltham Middlesex, at dawn and reaching New York before night. The trip will be accomplished on a specially designed very powerful Whitehead machine which is being built at our Middlesex factory. Edgar Middleton will accompany Mr. Sykes as navigator. He has served in an Essex regiment and was sub-lieutenant. Both are immensely enthusiastic and confident."

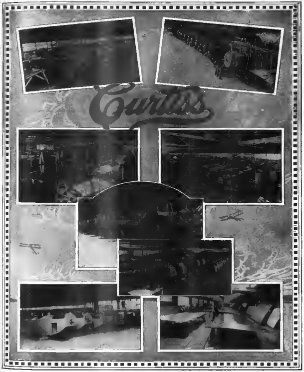
American airmen in England are dubious about the outcome of this scheme. An American officer pointed out to a *Daily News* representative the difficulties in the way at this time of year when equinoctial gales are due.

"The prevailing Atlantic winds," he said, "are from our side to yours, and experiments to be successful need a most favorable condition. A worse period for crossing to America from Europe could not be chosen than that between now and the end of next March. I see it is announced that the flight will occupy about 12 hr., which means 250 miles an hour in the teeth of the wind. Just look at the proposition."

Specifications Issued for Airplane Materials

Preliminary specifications for international standards of airplane materials are being issued by the International Airplane Standardization Board in Washington. This work has been in charge of F. G. Diffin, and copies of the Standards adopted may be obtained by manufacturers interested by application to the International Aircraft Standards Board, Room 224, Bond Building, Washington, D. C.

All international standards on airplane materials and fabricated parts in the future will be issued from the office of the Board, and can be had on application.



TURNBUCKLES

We Manufacture the Following Type Aeroplane Turnbuckles

Standard Type

No. 1 Female, Short A-1518	No. 2 Female, Long A-1520
No. 1 Male, Short A-1522	No. 3 Male, Long A-1524

Curtiss Type

326 Short, Male	327 Long, Female
326 Short, Female	327 Short, Female
326 Long, Female	328 Long, Female
327 Long, Male	329 Long, Female

The Dayton Metal Products Company

DAYTON, OHIO, U. S. A.

The Goodyear Kite-Balloon

The kite-balloon perfected by Goodyear combines the principles of the man-lifting kite and the captive balloon.

The first was unpractical because it required a strong wind.

The second was unsatisfactory because its use was limited to periods of calm.

Neither was stable, nor free enough from veering and yawing.

The Goodyear type of kite-balloon has fused the operating principles of both, selecting the best in each, so that it serves in storm and calm and furnishes a fixed, unwavering eye for artillery and fleet.

The carefully adjusted inclination of the elongated bag makes the plane of its nether surface a kite when the wind is on its front, and a resistant plane when the air currents are heavy on the back of the bag.

The refinements of keel construction, steadying side fins, and stabilizing tail-cups are Goodyear contributions to steadiness in air.

Every factor necessary to the fusion of the principles of kite and balloon has been developed or perfected —either in design or in material, or both.

Everything in Rubber for Airplanes
Balloons of Any Size and Every Type

The Goodyear Tire & Rubber Company, Akron, Ohio

GOODYEAR
AKRON

COURSE IN AERODYNAMICS AND AIRPLANE DESIGN

by the Instructors in Aeronautics of the Massachusetts Institute of Technology is printed complete in

BOUND VOLUMES Nos. I and II

of

Aviation and Aeronautical Engineering

Substantial and attractive bindings. These bound volumes contain nearly one thousand pages of matter of permanent value to the designer, constructor, accessory manufacturer and student of aeronautics. Prices, delivered anywhere in the United States or Canada

Volume I $5.00 *Volume II $4.00*

The GARDNER, MOFFAT COMPANY, Inc.
120 WEST 32nd STREET - - - - - - - - NEW YORK

Thomas

Contractors to U.S. Army and Navy

THOMAS-MORSE AIRCRAFT CORPORATION
ITHACA, N.Y. U.S.A.

Member Manufacturers Aircraft Association

Model T. T., 90 h. p. Training Tractor

WITTEMANN-LEWIS AIRCRAFT COMPANY

Lincoln Highway
Near Passaic River

Newark, N. J.
Telephone Market 9096

WALDEN-HINNERS COMPANY

BUILDERS OF AIRCRAFT

MILITARY AIRPLANES
SEAPLANES
FLYING BOATS

OFFICE AND FACTORY
EDGEWATER, N. J.

Licensed by and affiliated with Messrs. Leduc, Heitz & Co., Paris, France

AEROPLANE DOPE
of the
HIGHEST QUALITY
for

land and water machines built by constructors able to afford the best. Also gives excellent results and reduces fire risk when used for the last 2 or 3 coats over a cheaper dope

CONTRACTORS TO THE GOVERNMENT US

AMERICAN EMAILLITE COMPANY
555 W Washington Street
Chicago, Ill.

American Walnut Propellers

To supply the increasing demand for our product the *Excelsior Propeller Company* has been forced to increase its facilities We have reorganized our company under the new name of the

HARTZELL WALNUT PROPELLER CO.

and will occupy a modern three story factory at Piqua, Ohio, with 50,000 sq ft of floor space and all equipment necessary for the efficient manufacture of propellers in large quantities
From now on our propellers will be produced from American Walnut, guaranteeing greatest *durability and best possible finish*

With our new facilities we can give our customers prompt, efficient and satisfactory service.

HARTZELL WALNUT PROPELLER CO.
PIQUA, OHIO

Aeronautical Trade Directory

AVIATION AND AERONAUTICAL ENGINEERING will furnish information and addresses of all companies listed below. Names of Advertisers in this issue are printed in heavy face type.

ACETYLENE WELDING AND CUTTING
Cavis-Bournonville Co.
Searchlight Co.

ACCESSORIES AND INSTRUMENTS
DuVivier, Earnest J
Moto-Meter, The, Co.
Sperry Gyroscope Co.
Standard Aeronautical Co.
Taylor Instrument Companies

AIRPLANES
Aeromarine Sales and Engineering Corp.
American Automotive Corp.
Automotive Engineering Co.
Bates Aeroplane Co.
Benoist Aeroplane Co.
Boeing Airplane Co.
Burgess Co., The
Carter Bros. Aeroplane Co.
Curtiss Aeroplane and Motor Corp.
Dayton Wright Airplane Co.
Flint Aircraft Co.
Fowler Airplane Corp.
Gallaudet Aircraft Corp.
Hall, J. Robinson
Heinrich, The A. B. Corp.
Herrmann, Chas. A.
Jannus Aircraft Co.
L. W. F. Engineering Co.
Lanzius Aircraft Co.
Lawrence-Lewis Aeroplane Co.
Lawson Aircraft Co.
Lewis & Vought Corp.
Longren Airplane Co.
Ordnance Eng. Co.
Richardson Aeroplane Corp., Inc.
Rogers Construction Co.
Runner Aeroplane Co.
Smith, Eric H., Aircraft Co.
Standard Aero Corporation.
Sturtevant Aeroplane Co.
Thomas-Morse Aircraft Corp.
Walden-Blanco Co.
Williams Aeroplane Co.
Wittemann-Lewis Aircraft Co.
Wright-Martin Aircraft Corp.
Lewis G. Young.

AIRPLANE ENGINES
Aeromarine Plane and Motor Co.
Automotive Engineering Co.
Bournonville Motors Corp.
Cleveland Aero Motor Co.
Curtiss Aeroplane and Motor Corp.
Duesenberg Motors Corp.
General Ordnance Co.
General Vehicle Co.
Gyro Motor Co.
Hall, J. Robinson
Hall-Scott Motor Car Co.
Harriman Aircraft Motors Co.
Knox Motors Co.
Maximotor Co.
Miller, Harry A., Mfg. Co.
Otis Motor Co.
Packard Motor Co.
Roberts Motor Mfg. Co.
Sterling Engine Co.
Sturtevant, B. F., Co.
Thomas-Morse Aircraft Corp.
Union Gas Engine Co.
Wisconsin Motor Mfg. Co.
World's Motor Co.
Wright-Martin Aircraft Corp.

AIRPLANE PARTS
Auto-Aero Sheet Metal Co.
Century Telephone Construction Co.
Erie Specialty Co.
Lovett, Walker M. Co.
New Jersey Veneer Co.
Pressed & Welded Steel Prod. Co.
Rogers Construction Co.
Standard Parts Co.

ALUMINUM
Acieral Co. of America
Aluminum Castings Co.
Aluminum Co. of America
American Metal Co. Ltd.
Leygraaf & Co.
McAdamite Aluminum Co.
So-Luminum Mfg. & Eng. Co. (Solder)
United Smelting & Aluminum Co.

AVIATION SCHOOLS
Atlantic Coast Aeronautical Station
Beane School of Aviation
Curtiss Training Schools
Hydroaircraft Co.
Moisant Aviation School
Stinson School of Aviation

BALL BEARINGS
Gwilliam Co., The
Gurney Ball Bearing Co.
Hess-Bright Mfg. Co.
New Departure Mfg. Co.
Norma Company of America.
S. K. F. Ball Bearing Co.
U. S. Ball Bearing Mfg. Co.

BALLOONS, DIRIGIBLES
Connecticut Aircraft Co.
Cooler Specialty Co. (Statoscope)
Gas Engineering Co. (Gas Plants)
Goodyear Tire and Rubber Co.
United States Rubber Co.

BAROGRAPHS AND BAROMETERS
Green, Henry J
Hemsleter A.
Sandell & Lerch
Taylor Instrument Companies

BATTERIES
Electric Storage Battery Co.
Reese Miller Hutchinson, Inc

BEARING METALS
American Bronze Co.
Fahrig Metal Co.
Lovett, Walker M. Co.

BUSHINGS
Bound Brook Oil-Less Bearing Co.

CARBURETORS
Miller Carburetor Co.
Stromberg Motor Devices Co.
Wheeler and Schebler
Zenith Carburetor Co.

CLOCKS AND WATCHES
Chelsea Clock Co.
Depollier J., & Son
Waltham Watch Co.

CLOTHING
Abercrombie & Fitch
Rogers Peet & Co.
Sanders Co.
Spalding A. G. & Bros.

COMPASSES
Sperry Gyroscope Co.
Taylor Instrument Companies

DOPE AND VARNISH
Adams & Elting Co.
American Emaillite Co.
Chemical Products Co.
Cooper, The C. E. Co.
Delfast Chemical Works
Flexible Compound Co.
National Aeroplane Co.
Pratt & Lambert
Standard Varnish Works
Valentine & Co.
Weeks & Co.

DRIFT INDICATOR
Sperry Gyroscope Co.

DRY KILNS
Cutler Dry Kiln Co.
Grand Rapids Veneer Works

DYNAMOMETER
Sprague Electric Works

ENGINE PARTS
Akimoff, N. W.
Allegheny Forging Co.
Bard High Compression Ring Co.
Dollet, Theo. H. Co.
Doehler Die Casting Co.
Erie Specialty Co.
Fibre Finishing Co.
Gifford Leland Co.
Gill F. E. & Sons
Hydraulic Pressed Steel Co.
Lovett, Walker M. Co.
Park Drop Forge Co.
Standard Parts Co.
Toft Pierce Mfg. Co.
Tioga Steel & Iron Co.
Williams J. H. & Co.
Whitman & Barnes Mfg. Co.
Wyman-Gordon Co.

ENGINEERING
Automotive Engineering Co.
Ordnance Engineering Co.
Villepigue, George

FABRICS
Courtral Mfg. Co.
Lamb, Finlay & Co.
McBratney, Robt. & Co.
Whitman, Clarence & Co.

FIRE EXTINGUISHERS
Pyr-Fyter Co., The
Johns-Manville Co., H. W.
Pyrene Mfg. Co.

GAGES
Crosby Steam Gage & Valve Co.
Foxboro Co., The, Inc.
United States Gage Co.

GASKETS
Fibre Finishing Co.

GLUE
Ferdinand, L. W., & Co.
Reeder & Adamson.

GOGGLES
Straam & Buegeleisen

HANGARS
American Bridge Co.
Anchor Corrugating Constr. Co.
Ashley Steel Bldg. Co.
Howell, Field & Goddard, Inc.
Knasby & Mattison
Milliken Bros.
Pruden, C. D. Co.
Virginia Bridge & Iron Co.

LIFE PRESERVERS
Universal Safety Mattress Co.

LUMBER
Alcock Co., John L.
American Balsa Corp.
Chatham Lumber Co.
Delaloor J.
Colton, A. C. Lbr. Corp.
Ludlow Israel
Mengel C. C. & Bros. Co.

LUMINOUS COMPOUND
Cold Light Mfg. Co.
Radium Dial Co.
Radium Luminous Material Corp

MACHINERY, METAL WORKING
Dalton Mfg. Corp
Warner & Swasey Co.

MACHINERY, WOOD WORKING
Defiance Machine Works
Fox Machine Co.
Oliver & Warrin

MANIFOLDS
Ajax Auto & Aero Sheet Metal Co.

MAGNETOS
Bosch Magneto Co.
Berkshire Magneto Corp.
Ericsson Mfg. Co.
Remy Electric Co
Splitdorf Electrical Co

METALS
Acieral Co. of America
American Vanadium Co.
Bethlehem Steel Co.
Detroit Pressed Steel Co.
Federal Pressed Steel Co
Garland Ventilator Co.
Gueder Paeschke & Frey Co.
Lovett, Walker M. Co.
So-Luminum Mfg. Co.

MODEL AIRPLANES
Ideal Aeroplane Supply Co.
Wading River Mfg. Co.

MOTORCYCLES
Hendee Mfg. Co.

OILS AND LUBRICANTS
Baker Castor Oil Co.
Graphite Lubricant Co.
Gulf Refining Co
Sheppard Ideal Oil Co.
Standard Oil Co.
Swan & Finch
Texas Co
Vacuum Oil Co.

OIL PUMPS
Wayne Oil Tank & Pump Co.

PACKING
Fibre Finishing Co.

PHOTOGRAPHY
Breck, Arthur Jr
Herbert & Huesgen Co.

PISTONS
Lovett, Walker M., Co.

PISTON RINGS
American Piston Ring Co.

PONTOONS
Niagara Boat Co.
Palmer-Simpson Corp.
Welen Marine Equipment Co.

PROPELLERS
American Propeller & Mfg. Co.
Buffalo Aeroplane Corp.
Doyle, W. A.
Excelsior Propeller Co.
Harriman Aircraft Motors Co.
Hazel Walnut Propeller Co.
Lang Propeller Co.
Schweizer & West Mfg. Co.

PYROMETERS
Foxboro Co., The, Inc.
Shore Instrument & Mfg. Co.
Taylor Instrument Companies

RADIATORS
Auto Radiator Mfg. Corp.
Ajax Auto & Aero Sheet Metal Co.
Bush Mfg. Co.
El Arco Radiators Co.
English & Mersick Co.
Livingston Radiator Co.
Rome-Turney Radiator Co.

RIVETS
Stimpson, Edwin B. Co.

SCLEROSCOPE
Shore Instrument & Mfg. Co.

SHOCK ABSORBERS
Dural Rubber Corp.
Wood, J. W. Elastic Web Co.

SPARK PLUGS
Champion Ignition Co.
Johns-Manville Co. H. W
Pyre Ignition Co.
Rajah Auto Supply Co.
Splitdorf Electrical Co.

SPEED INDICATORS
Foxboro Co., The, Inc.
Johns-Manville Co., H. W
Stewart Warner Speedometer Corp

STABILIZERS
Greene Aeronautical Co.
Martin Aerodynamic Stabilizer
Sperry Gyroscope Co.

STAMPINGS
Lansing Stamping & Tool Co.

STARTERS
Bijur Motor Lighting Co.
Christensen, The, Engineering Co.
Dayton Engineering Laboratories Co
Motor Compressor Co.
Northeast Electric Co.
Wagner-Boyl Electric Co.

TACHOMETERS
Johns-Manville Co., H. W
Nelson Blower & Furnace Co.
Queen-Gray Co
Stewart Warner Speedometer Corp.
Veeder Mfg. Co.

TANKS
Jenney, Steinmetz & Co.

THERMOMETERS
Foxboro Co., The, Inc
Taylor Instrument Companies

TIRES AND RUBBER
Dural Rubber Corporation.
Goodyear Tire & Rubber Co.
Hodgman Rubber Co
United States Rubber Co.

TOOLS
Browne & Sharpe
Hall-Scott Motor Car Co.
Lansing Stamping & Tool Co.

TRUCKS AND TRAILERS
Federal Motor Truck Co.
Four Wheel Drive Auto Co.
Nash Motors Co.
Packard Motor Car Co
Sechler & Co., The
Service Motor Truck Co.
White Co

TUBING
Empire Art Metal Co
Frasse, Peter A. & Co.
Pennsylvania Flexible Metallic Tubing Co.

TURNBUCKLES
Cayton Metal Products Co.
Erie Specialty Co.
New York & Hagerstown Metal Stamping Co
Standard Screw Co.

WHEELS
Ackerman Wheel Co.
Mott Wheel Works
National Wire Wheel Works.
Wire Wheel Corporation of America.

WIRE
American Steel and Wire Co.
Century Telephone Construction Co.
Electric Cable Co.
Roebling's, John A., Sons
Simplex Wire and Cable Co.

WIRELESS
American Radio & Research Corp.
American Wireless Tel. Co.
Cutting & Washington.
Crocker-Wheeler Co

THE WILLIAMS PRINTING COMPANY, NEW YORK